ESME Workbench Enhancements

David C. Mountain, Ph.D.
Department of Biomedical Engineering
Boston University
44 Cummington St.
Boston, MA 02215
phone: (617) 353-4343 fax: (617) 353-6466 email: dcm@bu.edu

Award Number: N0001411C0448 & N000141210390
http://www.bu.edu/hrc/research/laboratories/auditory-biophysics/

LONG-TERM GOALS

The goal of the ESME Workbench project is to create a general purpose research tool for use by those who wish to study the effects of sound in the marine environment.

OBJECTIVES

Two versions of the One Navy Model will be created. The first version will designed for use by the US Navy and its subcontractors (classified version) and the second version will have equivalent functionality but will not use data or software codes that are classified or otherwise not available to the general public (unclassified version). After acceptance by NUWC, the features and algorithms in these software packages will remain unchanged during the current permitting cycle for US Navy training exercises while a third version of the simulation software (research version) will continue to evolve.

APPROACH

This project builds on the ongoing development of the ESME Workbench and is focused on redesigning and enhancing our existing code base to meet current Navy needs for simulating the impact of sound on marine animals. The key personnel are David Mountain (PI), David Anderson (research engineer), and Graham Voysey (research engineer).

The ESME Workbench is organized as a group major of software subsystems (Figure 1). These include a group of databases: Sound Source Database, Environmental Database, Marine Mammal Database, Sound Field Database, and the Simulation Output Database. The user interacts with a series of subsystems that are used to define the scenario, to run the acoustic simulations, and then to use the resulting sound fields to compute the received levels for all virtual animals in the simulation. The subsystems include Environment Builder, Scenario Builder, Acoustic Simulator, Scenario Simulator. The simulation location and environmental variables are visualized using a GIS like display (Figure 2).

Additional tools are included to view the acoustic fields generated by the Acoustic Simulator and summary statistics for the animal sound exposures from the Scenario Simulator.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2012	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
ESME Workbench Enhancements	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Department of Biomedical Engineering Boston University 44 Cummington St. Boston, MA 02215**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**4**	

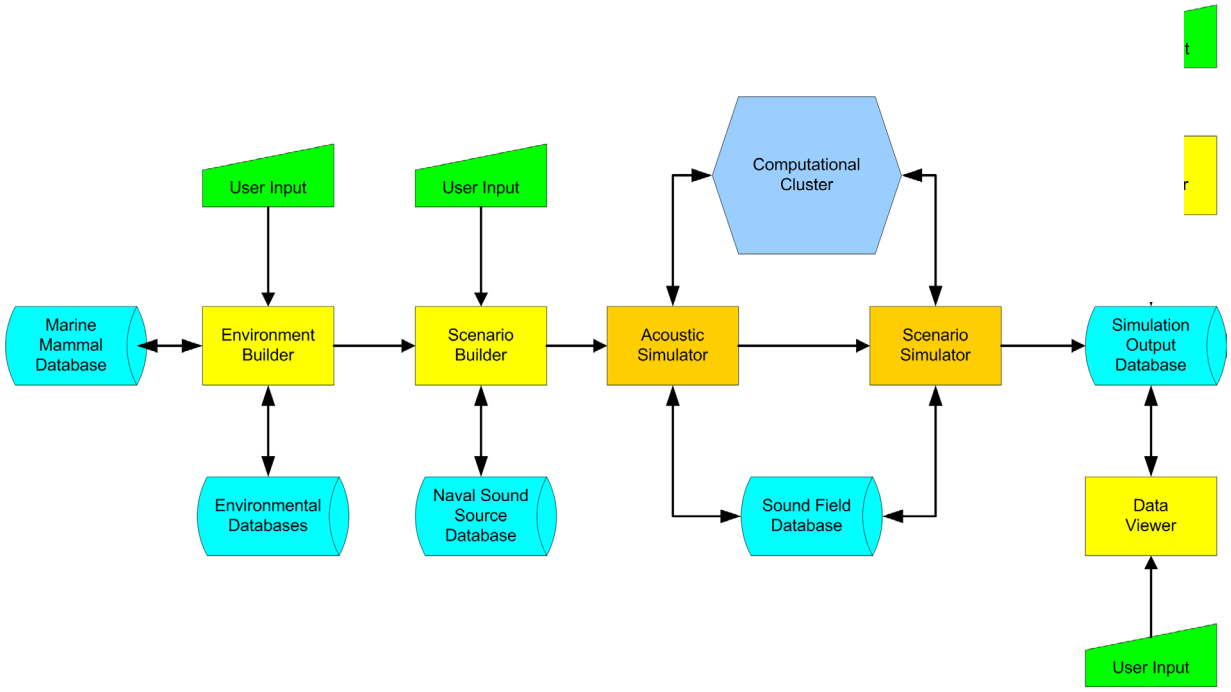

Figure 1. ESME Workbench conceptual block diagram

To create a Scenario, the user must first define the region (latitude and longitude) where the simulation will take place and the time of year and then load the needed environmental parameters (bathymetry, sediment types, sound speed profiles, and wind velocity). Then the user chooses platforms (e.g. surface ships) and their associated sound sources and source modes and defines the behavior of these platforms. The senario is then populated with virtual animals based on species and density.

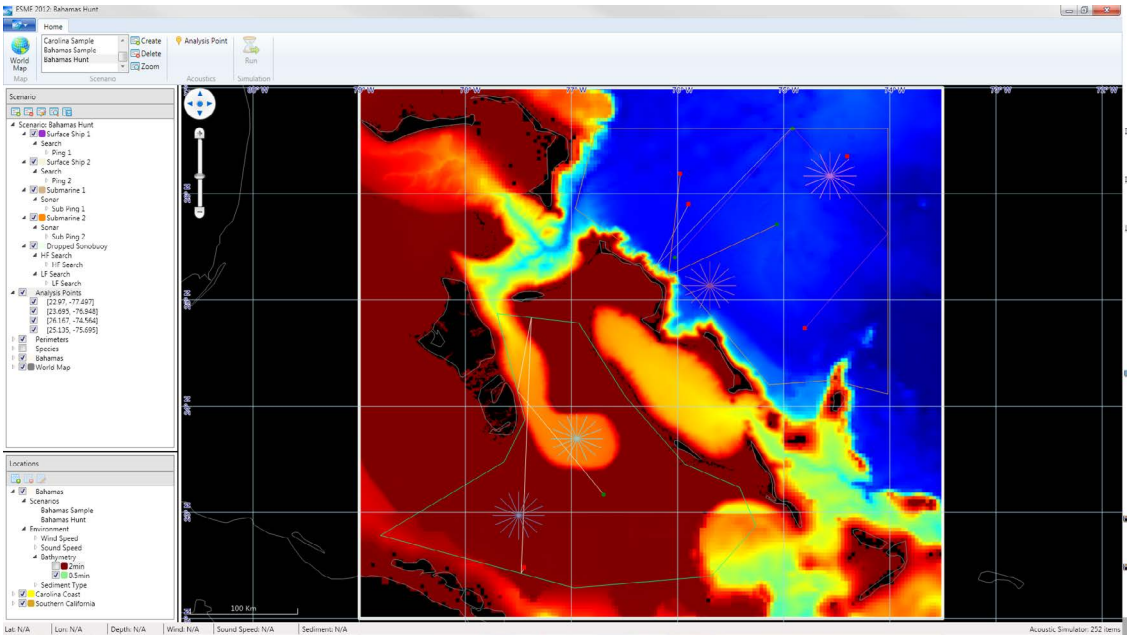

Figure 2. ESME Workbench user interface showing bathymetry and acoustic analysis points.

WORK COMPLETED

- Abstracted environmental data interface to support a more general plugin-style architecture, and demonstrated that this approach works using OAML databases. This is intended to make it easier for us to write additional plugins to support other environmental databases, both offline and online ones.
- Replaced a complicated system of files and directories with a sqlite database for experimental data management: more amenable to validation/verification, smaller, harder to crash, more reliable.
- Improved performance for the Scenario Simulator, maximizing system resource utilization to minimize simulation run time.
- Updated the Simulation Log to allow complete reconstruction of a given run while taking up minimal room on disk.
- Created a Matlab Simulation Log file interface as a preliminary step towards an open API. This will allow ESME users with access to Matlab to write custom analysis routines.
- Full integration of the 3MB animal movement model [1] for animat seeding.
- Full integration of 3MB for animat movement and behavior
- Addition of 19 new simulatable species. Any time a new species file is provided by the 3MB team, it will immediately be available for use in ESME
- Live-updating simulation graphics and plotting support. Allows the user to get a quick look at the simulation results as the simulation is
- More interactive map control for simulation design and display.
- Added the capability of choosing between the Bellhop [2] and RAM [3] algorithms for transmission loss calculation
- Increasing rapport with an international/research-diversegroup of users
- Increased the ESME web presence to drawn in and engage these users
- 600 unique visitors visited the ESME webpage over the past 3 months, from the US, Denmark, the UK, Italy, Canada, Spain, Australia, Lithuania, the Netherlands, and Brazil.
- 75 downloads of the second beta release -- 51 of whom also downloaded the quick start guide.
- US Navy, acoustic consulting firms, and major academic institutions constitute the most frequent visitors

RESULTS

We have created an improved scalable simulation system for studying the interaction between anthropogenic sound and marine life. The software is available for download from http://esme.bu.edu.

IMPACT/APPLICATIONS

The ESME Workbench was originally conceived of as a general purpose research tool for use by those who wish to study the effects of sound in the marine environment. The initial development efforts

have focused on the impact of naval sound sources on the hearing and behavior of marine mammals. During the current fiscal year, the development effort has been focused on improving the performance and robustness of the simulation system and on improving the user interface. The improved system can be used to simulate naval training exercises for environmental compliance purposes based on reporting requirements that are being negotiated between N45 and the National Marine Fisheries Service as well as be used to simulate other types of sound sources and scenarios.

RELATED PROJECTS

N000141110408 Effects of sound on the marine environment. PI: Martin Siderius

The Siderius group has been assisting our team with with the implementation of acoustic propagation models as well as with testing of the ESME software.

REFERENCES

1. Houser DS (2006). A method for modeling marine mammal movement and behavior for environmental impact assessment. IEEE J Ocean Eng 31:76–81.
2. Porter MB, Liu YC (1994). Finite-element ray tracing. In: Lee D, Shultz MH (eds) Theoretical and computational acoustics, vol. 2. World Scientific Publishing, Singapore.
3. Collins MD (1993). A split-step Padé solution for the parabolic equation method. J. Acoust. Soc. Am. 93:1736-1742.

PUBLICATIONS

Mountain DC, Anderson D, Brughera A, Cross M, Houser DS, Musleh N, Porter M, Siderius M. (2012). The ESME workbench: simulating the impact of anthropogenic sound on marine mammals. Adv Exp Med Biol. 730:221-3. [published]